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METHOD AND SYSTEM FOR PREVENTIVE PROTECTION OF VEHICLE OCCUPANTS IN DANGEROUS SITUATIONS

Background Information

The protection of vehicle occupants in the case of an accident by deploying irreversible restraining means (airbags in particular) is nowadays standard, the irreversible restraining means being pyrotechnically ignited when an impact is detected by acceleration sensors in particular.

In addition, it has also become customary to investigate, even prior to the actual impact, whether there is an imminent risk of such an impact. As a function thereof, the irreversible restraining means are set to a state of readiness to very quickly enable the actual deployment when the impact is detected. Furthermore, reversible restraining means, power safety belt tensioners in particular, are activated to forcibly move the affected occupants into the best possible position in the seat. This is briefly explained below with reference to Figure 5. Figure 5 shows two vehicles 21 and 22, which move toward one another at velocities V_1 and V_2, respectively. While vehicle 21 is traveling on its proper right side of the road 23, second vehicle 22 has left its proper right side of the road 24. This means that there is a latent risk of collision between vehicles 21 and 22. In any case, when the distance between the two vehicles 21 and 22 traveling at a certain relative velocity ($V_1 + V_2$) drops below a certain distance, i.e., the time to impact (time = distance/relative velocity)drops below a certain time, a collision must be considered as unavoidable. When such a situation is detected, the above-mentioned preventive measures are initiated.

This procedure is basically also applicable if a single vehicle moves toward a stationary obstacle, i.e., object. Also in this case, an analyzer circuit of the vehicle will use the relative velocity with respect to the object and the distance to the object to evaluate whether or not a collision is imminent.

The conventional modes of operation thus assume the actual occurrence of a collision (crash) or the detection of an imminent, unavoidable collision.

SUBSTITUTE SPECIFICATION

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However, the known procedures do not allow for a response to events in which the vehicle gradually approaches an object such as a guardrail, a wall, stationary, parked or slowly moving vehicles, or the like. Forces which may result in injuries, due to impact with vehicle parts in particular, may act upon vehicle occupants, unaware occupants in particular, even in the event of such a grazing contact.

An object of the present invention is therefore to provide a method and a system to effectively protect vehicle occupants even in non-impact danger situations.

Summary Of The Invention

This object is achieved by a method for preventive protection of vehicle occupants in dangerous situations by determining the distance of the vehicle to objects on the roadside according to size on an ongoing basis, determining whether this distance is less than a critical distance, and initiating protective measures in response to such a determination.

A system for carrying out the method is characterized by appropriate sensors and an analyzer circuit.

It is to be assumed that the appropriate sensor system for detecting objects in the vehicle's surroundings is already present in the vehicle, and thus the relative distance of the host vehicle to objects on the roadside, such as guardrails, parked cars, walls, and the like, is detectable, and furthermore sensors for determining the host vehicle velocity are also available. Therefore, only one analyzer circuit must be provided, which determines whether or not the actual distance is less than a critical distance. Appropriate measures may be taken on the basis of this determination.

The critical distance is preferably determined as a function of the relative velocity of the vehicle with respect to the object on the roadside.

Brief Description Of The Drawings

Figure 1 schematically shows the basic structure of a system for carrying out the method according to the present invention.

Figure 2 schematically shows the consequences and perils of a vehicle gradually approaching an object on the roadside such as a guardrail.

Figure 3 shows two typical situations of a vehicle to elucidate the present invention.

Figure 4 shows the curve of the preferred dependence of the critical distance on the host vehicle velocity.

Figure 5 schematically shows the conventional situation in the event of an imminent collision.

Detailed Description

First, the dangers as vehicle 1 gradually approaches a guardrail 2 on the roadside are explained with reference to Figure 2. According to the different representations of Figure 2, vehicle 2 approaches a guardrail 2 very gradually, i.e., at a very small angle. Conventional collision detection systems do not recognize this situation as a (possible) collision. Such situations may often occur, for example, due to the driver's lax attentiveness, unfavorable visibility conditions, a narrowing roadway at construction sites, or the like. Therefore, the contact of vehicle 1 with guardrail 2 is not an impact, but a grazing contact 3 which, in any case at higher vehicle speeds V_{host} may result in rotational pulses 4 and therefore in deformations 5 of the guardrail and 6 of vehicle 1. The forces thus generated also act on the vehicle's occupants; high centrifugal forces are generated by the rotation due to rotational pulses 4. Therefore, it is possible that vehicle occupants are thrown against vehicle parts, where they may become injured.
Figure 1 shows a system responding, according to the present invention, to situations which are dangerous for the vehicle's occupants.

With the aid of suitable sensors or by the processing of signals delivered by sensors provided in vehicle 1, first of all, distance a or the offset of vehicle 1 with respect to the edge of the roadway, particularly guardrail 2, as ascertained, and is compared in a comparator circuit 7 to a critical distance a_{crit} provided and fed by a memory 8. If actual distance a is less than critical distance a_{crit}, comparator circuit 7 outputs corresponding a signal 13 to a trigger circuit 9, which is provided for triggering and

deploying different restraining means, for example, irreversible restraining means 10, such as air bags, pyrotechnically ignitable seat belt tensioners, and the like, and reversible restraining means 11, such as power-activated seat belt tensioners, trigger circuit 9 basically operating in a conventional manner on the basis of other signals 12 and acting on restraining means 10 and 11 in the event of a collision.

Signal 13, indicating that the actual distance is less than critical distance a_{crit}, is used according to the present invention to activate reversible restraining means 11. It may also be used to prepare the activation of irreversible restraining means 10, because it cannot be ruled out that even a gradual approach may result in a collision which makes the deployment of irreversible restraining means 10 seem necessary.

The potential danger for the occupants of a vehicle 1 in the event of such a gradual approach to a roadside object, such as a guardrail 2, may be considered a function of velocity V_{host} of host vehicle 1. Figure 3 shows two vehicles 14 and 15 traveling at the same velocity V_{host} but at different distances to the roadside a_{14} and a_{15}, respectively. It is obvious that, given the same velocity, the danger of contact is considerably greater for vehicle 15, which is closer to guardrail 2, than for the other vehicle 14. Empirical studies have found that, as of a certain distance from guardrail 2, the danger of gradual contact with guardrail 2 is independent of vehicle velocity V_{host}. Empirical studies have furthermore shown that, below a certain vehicle velocity, even given a very small distance to guardrail 2, a grazing contact which could be dangerous for vehicle occupants is no longer to be expected. Therefore, it is advisable, as shown in Figure 1, to also determine the host vehicle velocity, and to supply a corresponding signal V_{host} to comparator circuit 7, and furthermore to store in memory 8 the dependence of critical distance a_{crit} on host vehicle velocity V_{host}, shown schematically in Figure 4, and to retrieve critical distance a_{crit} assigned to the respective host vehicle velocity from memory 8 and compare it to actual distance a in comparator 7.

According to one refinement of the present invention, if actual distance a is less than a critical distance a_{crit}, it is advisable to activate an acoustic and/or visual alarm 16, schematically represented by a loudspeaker, to call the driver's attention to this situation which is potentially dangerous for the vehicle's occupants.

In this context, and what is not shown in detail, the values for critical distance a_{crit}, whose undershooting triggers alarm 16 and whose undershooting triggers the deployment of irreversible restraining means, may differ, the values in the first case being higher than in the second case. Alarm 16 may not only be triggered by trigger circuit 9, but also directly by comparator 7.

It is to be pointed out that distance a of vehicle 1 from guardrail 2 and other roadside objects may be determined directly by sensors which are already customary such as video, radar, lidar, ultrasound, and the like or derived from corresponding signals. Velocity V_{host} of host vehicle 1 may be determined, for example, by detecting the wheel speed or retrieved from an on-board system such as a CAN on-board bus.

If the situation that gave rise to signal 13 no longer exists, i.e., the corresponding danger is no longer present, reversible restraining means 11 are reset and alarm 16 is deactivated. This danger situation is no longer present if actual distance a is again (clearly) greater than critical distance a_{crit} or if the vehicle has stopped, or the vehicle is traveling at a velocity which is (clearly) less than the minimum vehicle velocity according to the curve of Figure 4.